US TDAQ Phase-II Planning

Introduction

- TDAQ WBS less concrete by its nature but have to forward quickly to meet the challenging schedule
- Some significant changes proposed for TDAQ Phase-II upgrade since LoI, and various scenarios being exercised in re-costing process
- Changes foreseen and to be discussed today

TDAQ Phase-II Upgrade

❖ Motivation

- Low single lepton thresholds (~20 GeV) needed to fully exploit the HL-LHC physics program
- Hadronic tau decays important for Higgs and new physics studies
- Fully hadronic triggers needed for missing energy, multijets, etc for SUSY and DM studies

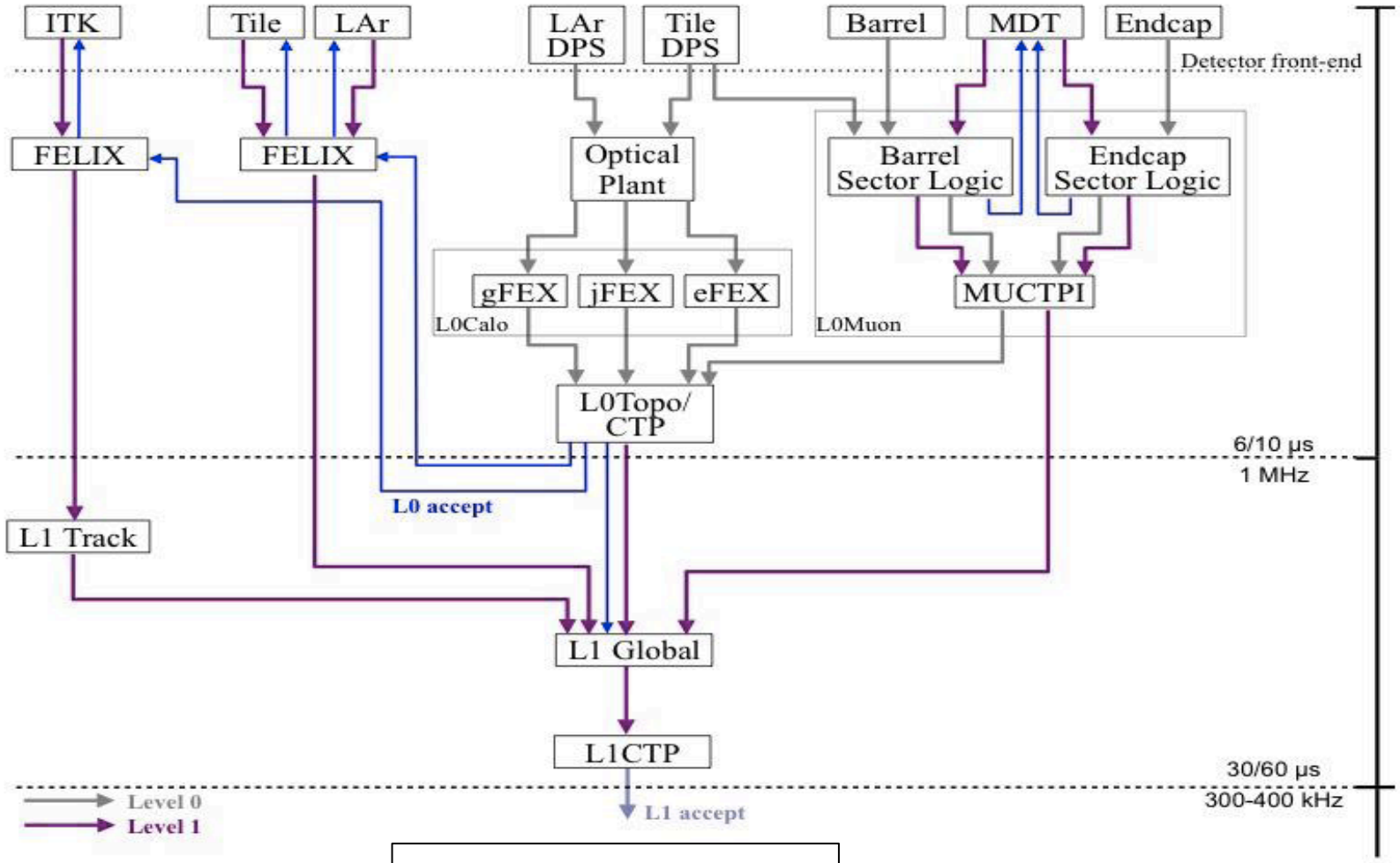
❖ Spec highlights (evolving since LoI)

- Split L0/L1 architecture
- Rate and latency (L0: 1 MHz, 6 μs; L1: 300-400 kHz, 30 μs)
- Phase-I L1CALO to be Phase-II L0CALO
- L1Track to be FTK-like and RoI based
- FELIX as new detector readout

❖ Timeline

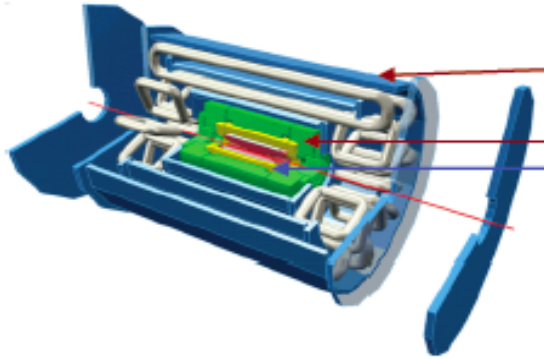
- IDR in Q1 2016
- TDR in Q4 2017

Phase-II Trigger Architecture



HLT including FTK++

Phase-II DAQ



Levels of Selection		3
Selection rate (kHz)	Level-0	1000
	Level-1	400
	Event Filter	10
Detector links		9000
Event size (MB)	Raw	~5
	Compressed	~3*
Network	Bandwidth (GB/s)	1000
	Connections (40 Gb/s)	1000
Storage	Rate (kHz)	10
	Bandwidth (GB/s)	~30*

* after compression at Event Filter

Earlier US WBS

WBS	Description	Institutes
6.6.1	Track Trigger	
6.6.1.1	L1Track	ANL, Indiana, Penn, SLAC
6.6.1.2	FTK upgrade	Chicago, NIU, UIUC
6.6.2	Calorimeter Trigger	
6.6.2.1	L0CALO	Chicago, Indiana, MSU
6.6.2.2	L1CALO	BNL, Chicago, Indiana, Louisiana, MSU, Oregon, Penn, Pittsburgh
6.6.3	Readout/DAQ	
6.6.3.1	FELIX	ANL, BNL, Oregon
6.6.3.2	ITK Readout	SLAC

Recent Updates

- Contacted with the 12 institutes on the existing WBS (May 13) to collect
  - Interests with concrete details if possible
  - Personnel, FTEs, time profile, fully burdened rate
- Reminded on responses (May 27)
- Got reply from most institutes
  - Interests mostly consistent with existing understanding
  - A few new items
- More feedback today

US Interests Expressed

Institute	Area	FTE/year
ANL	L0CALO (RoID), L1Track (AM carrier), FELIX Readout	2.5 FTEs
BNL	L1Global, FELIX readout	3.0 FTEs
Chicago	FTK++ (tracking fitting), L1Global (jet algorithms)	2.0 FTEs
UIUC	FTK++ (second stage)	1.0 FTE
Indiana	L0CALO, L1Global, L1Track	2.0 FTEs
Louisiana Tech	GPU for jet triggers	*
MSU	L0CALO (Topo cluster in LAr DPS)	3.5 FTEs
NIU	FTK++ (firmware)	1.0 FTE
Oregon	L1Global (Topo cluster, jet algorithms)	1.0 FTE
Penn	L1Track	1.0 FTE
Pittsburgh	Extend gFEX related work	*
SLAC	L1Track (Data Formatter), ITK readout	1.5 FTEs
Stanford	FTK++	

Software Interests

Institutes	Area	
UCI	Dataflow software	
Wisconsin	Dataflow and HLT core software	

Comments on TDAQ Software

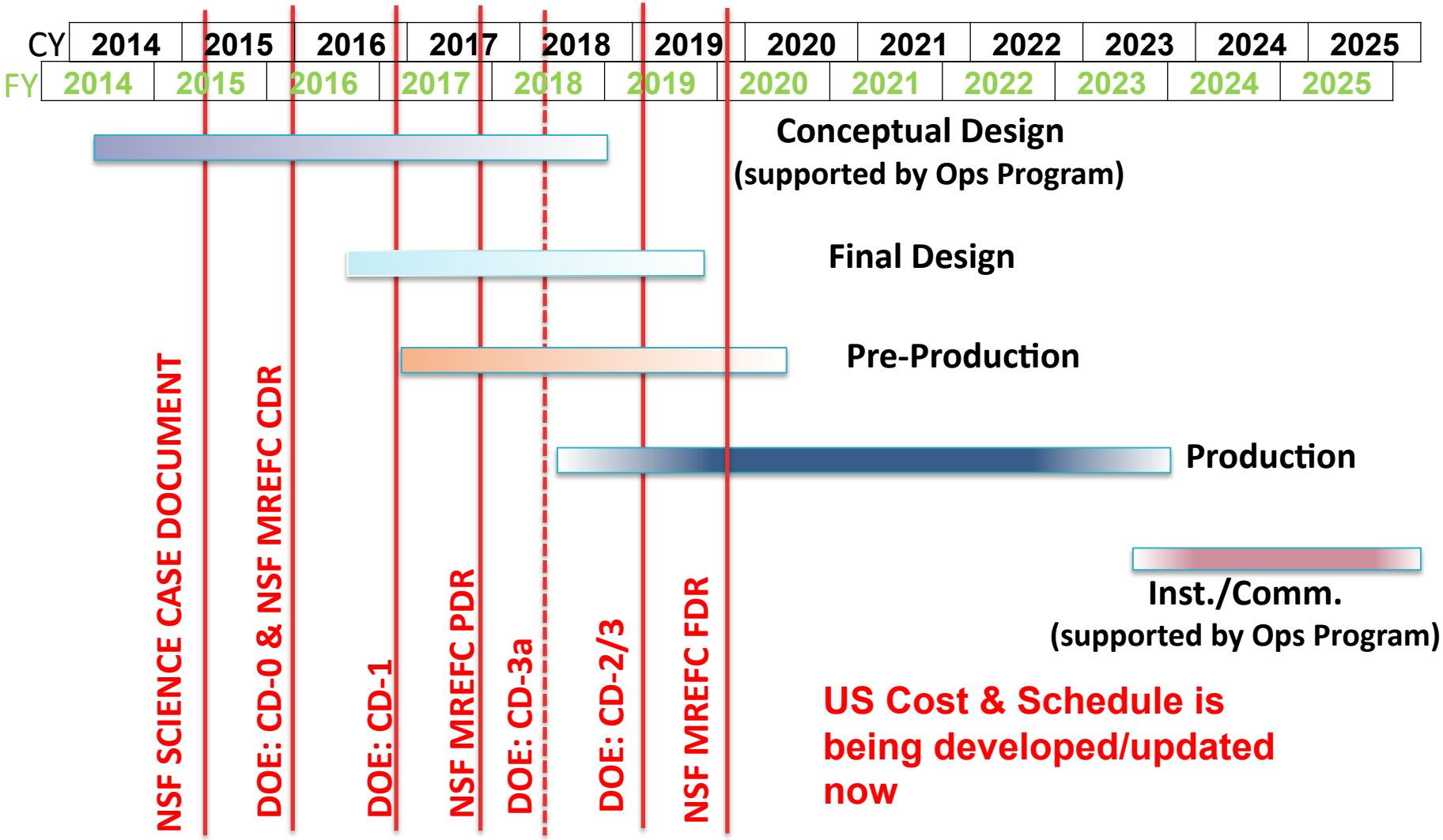
- TDAQ software not part of construction project but a critical component to ensure the project success and operation afterwards
- Large contributions to TDAQ software in operation from US, and some areas benefitting both Phase-I and Phase-I upgrade
- Prepare a WBS (though not costing) with information on current US contributions on TDAQ software potentially benefitting Phase-II upgrade, and the contributions needed to Phase-II projects in order to maintain the similar level of impact
- Software supported by the different part of the USATLAS program

TDAQ Scoping Scenarios

	L0 rate [kHz]	L1 rate [kHz]	EF Rate [kHz]	Barrel Muon Eff.**	Fwrd Muons (RoI) η	L1 Track η	L1 Track p_T [GeV]	Forward Electons/ photons η	FTK++ p_T [GeV]	FTK++ Rate [kHz]
LoI	>500	200	5-10	~70%	-	2.4	-	-	-	-
Upper	**1000**	**400**	**10**	**>95%**	**2.6-4.0**	**4.0**	**4**	**2.4-4.0**	**1**	**100**
Middle	1000	200	5	~82%	-	3.2	4	2.4-3.2*	1	50
Lower	1000	200	5	~70%	-	2.4	8	-	2	50

- "Detector" sections done by end-June, may provide to LHCC for discussion; "feature complete" draft to LHCC/UCG by July 31 – still missing significant performance and physics parts
- Aug 10 –circulate to ATLAS; comments by Aug 24; Aug 28 EB approval
- Sept 1- transmit final documents to LHCC/UCG (Upgrade Cost Group)
- More steps followed at higher levels (see M. Tuts' talk at recent USATLAS workshop)

Timeline for Proposals/Reviews



Process for Developing Scope

- U.S. Scope (deliverables) expressed in a WBS + Budget/Schedule
  - being developed by L2 Managers

WBS	System	L2 Manager
6.1	Pixels	P. Grenier (SLAC)
6.3	LAr	J. Parsons (Columbia)
6.5	Muons	T. Schwarz (Michigan)

WBS	System	L2 Manager
6.2	Strips	C. Haber (LBNL)
6.4	TileCal	M. Oreglia (Chicago)
6.6	TDAQ	E. Lipeles (Penn), J. Zhang (ANL)

  - driven by expertise developed in the U.S. (reflected in R&D program)
  - current status summarized on next slides

- Timeline for WBS/Budget/Schedule
  - Aug/Sep 2015: scrubbing of sub-system WBS/Budget/Schedule
  - Oct 2015: snapshot "frozen" for CD-0/CDR
  - 2016-18: further scope development for CD-1,2/3 / PDR/FDR
    - note that scope changes become more difficult with time
  - end 2018: scope is fixed after CD-2/3 / FDR

From H .Evans

ATLAS TDAQ WBS

WBS	description	Reference [kCHF]	Medium [kCHF]	Low [kCHF]
1.1	Level-0			
1.1.1	L0Calo			
1.1.2	Level-0 Muon RPC			
1.1.3	Level-0 Muon TGC			
1.1.4	Level-0 Muon MDT			
1.2	Hardware tracking			
1.2.1	L1Track			
1.2.2	FKT++			
1.3	L1Global			
1.4	Central Trigger Processor			
1.4.1	L0CTP			
1.4.2	L1CTP			
1.5	DAQ/HLT			
1.5.1	FELIX and Network			
1.5.2	Data Flow			
1.5.3	Event Filter			

New WBS Structure (just started)

6.6		
6.6.1	Level-0 Trigger	
6.6.1.1	L0Calo	ANL, Chicago, Indiana, MSU
6.6.2	Hardware Tracking	
6.6.2.1	L1Track	ANL, Indiana, Penn, SLAC
6.6.2.2	FTK++	Chicago, NIU, Stanford, UIUC
6.6.3	L1Global	BNL, Chicago, Indiana, Louisiana, MSU, Oregon, Penn, Pitt
6.6.4	DAQ/HLT	
6.6.4.1	FELIX & Network	ANL, BNL, Oregon, SLAC

Initial Thought on Details

- L0CTP
  - RoI distribution
- L0CALO
  - TOPO clustering in DPS
  - Advanced algorithm firmware
  - … …
- L1Track
  - Pre-processor
  - AM carrier
  - Track fitting
  - Output data handling
  - … …
- FTK++
  - Data Formatter
  - Data organizer and track fitting
  - Second stage
  - … …
- L1Global
  - Aggregator
  - Event processor hardware
  - Event processor firmware
    - CALO
      (e/γ, τ, jet)
    - Track combination
      (e, μ, τ, multi-jet/MET)
  - Output data handling
  - … …
- FELIX & network
  - FELIX hardware
  - FELIX firmware
  - Detector data handling
  - … …

Next Steps

- Incorperate the input we get today
- Work with TDAQ management and project coordinators
  - To incorporate the changes introduced into the projects US interested in
  - To identify the suitable deliverables for US institutes
- Develop the WBS structure, include cost and effort
  - Board design
  - Control firmware
  - Algorithm firmware 1
  - Algorithm firmware N
- Discuss with all US TDAQ institutes (a meeting like this) once the draft WBS available

TDAQ Scoping

Detector System	Ref. (275MCHF)	Middle (235 MCHF)	Low (200MCHF)
Trigger and Data Acquisition			
Level-0 Central Trigger	✓	✓	✓
Level-0 Calorimeter Trigger e/γ *	✓ $\|\eta\| \leq 4$	✓ $\|\eta\| \leq 3.2$	✓ $\|\eta\| \leq 2.5$
Level-0 Muon Barrel Trigger	✓ All MDT, RPC-BI, Tile μ	✓ BM & BO only MDT, partial η RPC-BI, Tile μ	✓ BM & BO only MDT, No RPC-BI, Tile μ
Level-0 Muon Endcap Trigger	✓ ($\|\eta\| \leq 4$), All MDT	✓ $\|\eta\| \leq 3.2$, EE & EM MDT only	✓ $\|\eta\| \leq 2.5$, EE & EM MDT only
Level-1 Output rate [kHz]	400	200	200
Level-1 Central Trigger	✓	✓	✓
Level-1 Global Trigger *	✓	✓	✓
Level-1 Track Trigger *	✓ $\|\eta\| \leq 4, p_T >$ 4 GeV	✓ $\|\eta\| \leq 3.2, p_T >$ 4 GeV	✓ $\|\eta\| \leq 3.2, p_T >$ 8 GeV
HLT FTK++ *	✓ $p_T >$ 1 GeV, 100kHz	✓ $p_T >$ 1 GeV, 50kHz	✓ $p_T >$ 2 GeV, 50kHz
HLT Event Filter	✓ 10kHz output	✓ 5kHz output	✓ 5kHz output
DAQ Detect. Readout *, Data Flow	✓ 400kHz L1 rate	✓ 200kHz L1 rate	✓ 200kHz L1 rate